

Evidence of an Undescribed, Extinct *Philodoria* Species (Lepidoptera: Gracillariidae) from Hawaiian *Hesperomannia* Herbarium Specimens

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The Hawaiian endemic leaf-mining moth genus *Philodoria* Walsingham 1907 (Lepidoptera: Gracillariidae) is composed of 30 described species (Zimmerman 1978). Most *Philodoria* species are monophagous, but the genus as a whole is known to feed within the leaf tissue of 12 families of endemic Hawaiian host plants (Swezey 1954, Zimmerman 1978). Several members of the genus are closely associated with endemic plant lineages, including the silversword alliance and the Hawaiian lobelioids, but their complete host plant range and classification remain unclear. Many of *Philodoria*'s known host plant genera included threatened or endangered species (IUCN 2013). Considering the group's extensive host plant range and the host specificity of each species, it is likely that there are undescribed *Philodoria* that specialize on rare members of recorded host plant genera. Such interactions would indicate a need for conservation of these native moths. Despite their unique life history and potential need for conservation, *Philodoria* has received little scientific attention since its description over a century ago.

Because of their extreme host specificity, leaf miners provide an excellent opportunity to study plant-insect interactions (Opler 1974). Leaf mine characteristics such as shape, length, frass quantity,

and blotch formation are often distinctive at the genus or species level. Leaf mines preserved in fossils and herbarium specimens are useful media for capturing historical leaf miner activity (Crane and Jarzembski 1980). Recently, herbarium specimens were used to infer the historical distribution and interaction between a leaf-mining moth and its host plant (Lees et al. 2011). In the present report, we conducted a preliminary analysis of native *Philodoria* leaf mines preserved in herbarium specimens stored at the Bernice Pauahi Bishop Museum's Herbarium Pacificum (BISH). The survey involved visual inspection of specimens of threatened or endangered species in five genera within known host plant families: *Neraudia* Gaud. (Rosales: Urticaceae), *Urera* Gaud. (Rosales: Urticaceae), *Remya* Hillebr. ex Benth. (Asterales: Asteraceae), *Argyroxiphium* DC (Asterales: Asteraceae), and *Hesperomannia* A. Gray (Asterales: Asteraceae).

Our examination of *Hesperomannia* herbarium specimens revealed leaf mines, pupae, and pupal cases on the adaxial leaf surface of *Hesperomannia arborescens* collected from Lanai in 1929 (Fig. 1). The Lanai population of *H. arborescens* is believed to be extinct (Wagner et al. 1990, Morden and Harbin 2013). Currently, only one species of *Philodoria* is known from



Figure 1. *Philodoria* pupal tents on the adaxial surface of *Hesperomannia arborescens* leaves from Lanai (BISH1022034).

Lanai, *P. splendida* Walsingham 1907, which mines the leaves of *Metrosideros polymorpha* (Myrtales: Myrtaceae), and is highly unlikely to occur on *Hesperomannia*. Ten described and undescribed *Philodoria* species are known to feed on Hawaiian Asteraceae. There is only one record from Kauai of a *Hesperomannia* miner, but no adults or larvae were ever collected (Swezey 1940). Furthermore, nine of these *Philodoria* species associated with asters are single-island endemics. This suggests that the mines on *Hesperomannia* herbarium specimens were caused by an undescribed, extinct species of *Philodoria* from the island of Lanai.

Recent field observations by the second and third authors of the remaining wild populations of *Hesperomannia* species on Kauai and Maui suggest additional instances of unrecorded *Philodoria* species. These observations likely represent undescribed species endemic to their respective island as well. Since all *Hesperomannia* species are critically endangered (IUCN 2013) and the *Philodoria* species that feed on them are thought to be specialists, it is crucial that we continue to gather basic biological data from these endemic leaf miners. Building on these basic life history data, we plan to study the population dynamics and evolution of *Philodoria* in

order to prioritize conservation efforts for both these moths and their hosts.

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